Carbonate Depositional Motifs and Cycle Stacking Patterns in the Eagle Ford Formation, Texas*

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Abstract

The Eagle Ford formation, Texas, is predominantly a carbonate succession consisting of interbedded limestones and black marlstones. The Eagle Ford presents a number of distinct facies that exhibit distinct internally recurring motifs or facies associations. Using an example from outcrop near Del Rio, Texas, these motifs (from base to top) include: 1. Reworked chaotic with cross-stratified foram grainstones; 2. Homogeneous/laminated foram-rich packstones/grainstones interbedded with black marlstones; 3. bioturbated, pelleted wackestones and packstones interbedded with black marlstones; 4. bioturbated pelleted/skeletal wackestones and packstones interbedded with gray marlstones; 5. Nodular packstones and grainstones with interbedded gray marlstones; and 6. bioturbated chalky wackestones with interbedded marls. Depositional cycles within the Eagle Ford cannot be deciphered in the traditional sense of delineating shallowing-upwards facies successions because determining differences in actual water depth within individual successions is speculative at best. Nevertheless, Eagle Ford depositional cycles were described as those successions proceeding upward from black mudrock or marl upwards through a bed of carbonate sediment, which is a general trend that repeats throughout the formation.

Stacking pattern analysis of Eagle Ford indicates that the Eagle ford can be divided into three distinct intervals related directly to carbonate motifs.

These include: the classic lower Eagle Ford (predominantly current or storm reworked at the base, followed by pelagic sedimentation) where cycles tend to be comparably thin (characterized by motifs 1 and 2); the classic upper Eagle Ford (a combination of pelagic and in-situ carbonate sedimentation, with intensity of bioturbation and carbonate content increasing upward) where cycles thicken and thin upward into recognizable cycle sets (characterized by motifs 3 and 4); and a topmost member cycles again thin upwards into the overlying Austin chalk (characterized by motifs 5 and 6).

Similar depositional patterns linked to biostratigraphy are observed in outcrops in both West Texas and Central Texas and help unravel the depositional history of basin infill.

References Cited

Goldhammer, R.K., 1999, Paleogeographic and sequence stratigraphic framework for Mesozoic carbonate exploration on the Northwest Gulf of Mexico (NW GOM) rim: AAPG Annual Meeting Expanded Abstracts, p. A48.

Hazzard, R.T., 1959, The age of the yellowish marl above the Georgetown in northwestern Val verde County and southwestern Crockett County, a discussion: West Texas Geological Society Guidebook, p. 60-63.

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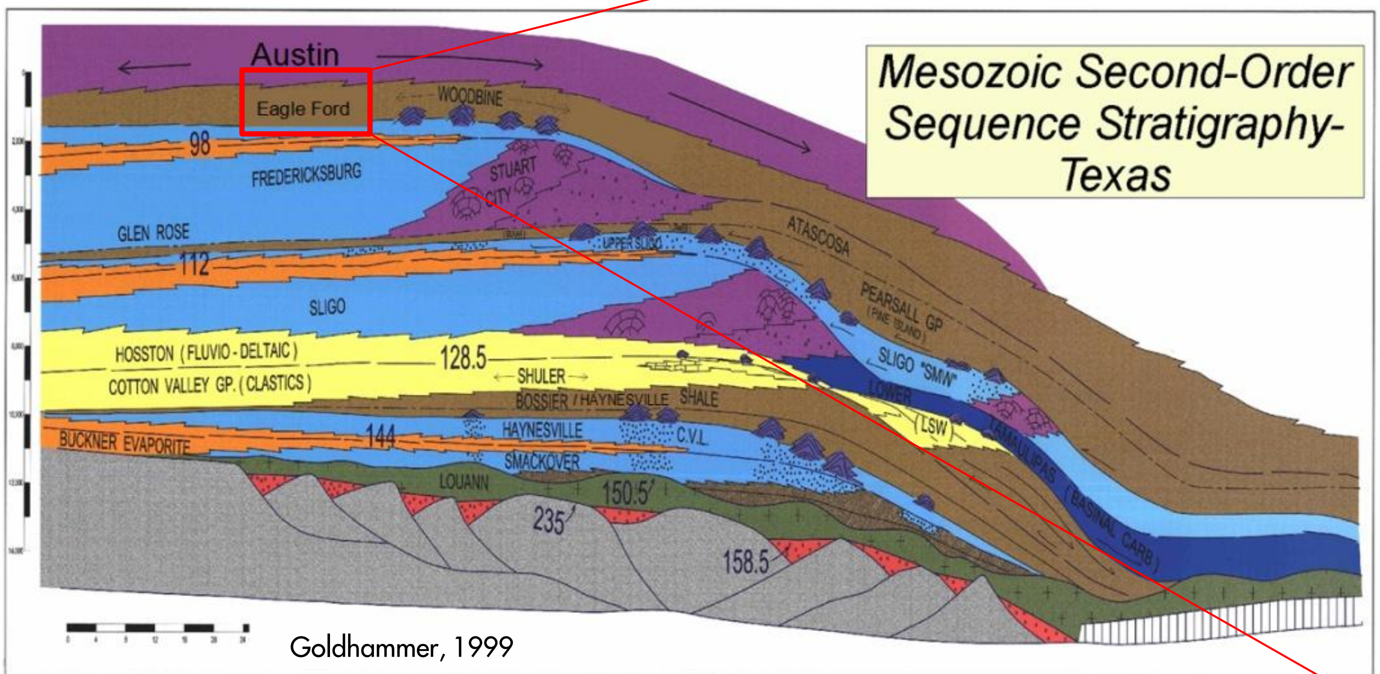
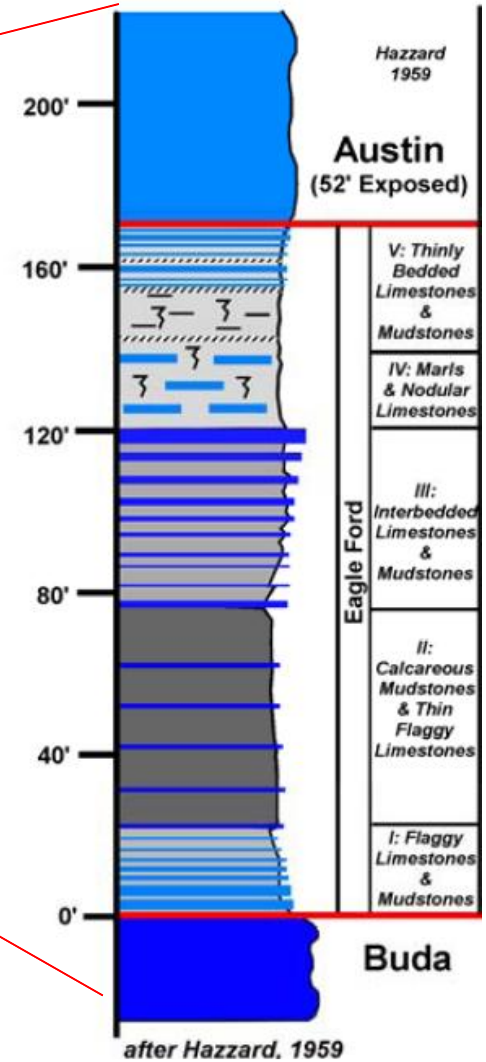
Purpose

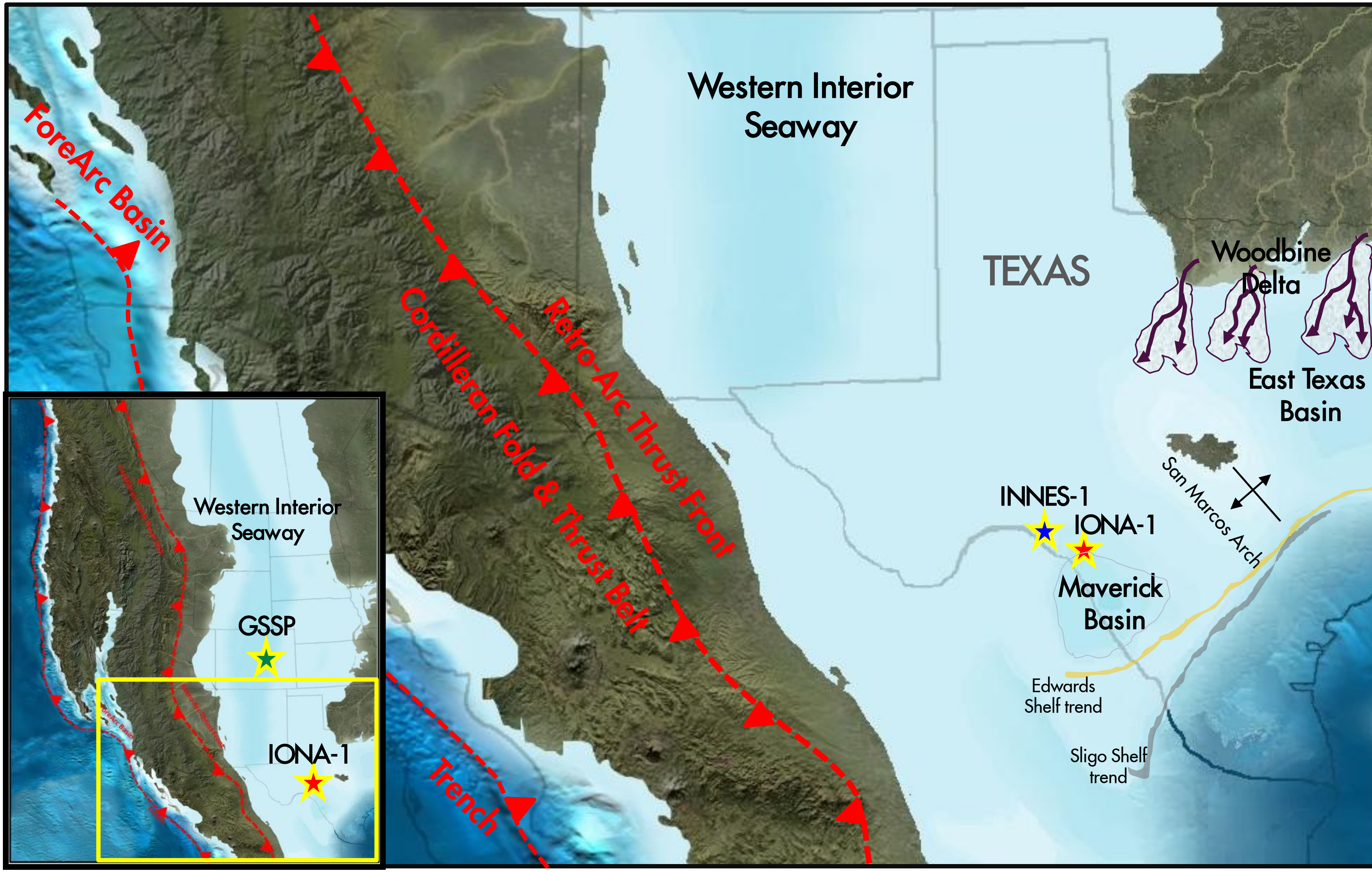
- Delineate depositional themes in the Eagle Ford that relate to stratigraphic packaging using data obtained from two Shell research cores, Iona and Innes.

- Examine how Eagle Ford cycles stack vertically, correlate, and relate to depositional setting between wells.

Eagle Ford stratigraphic context







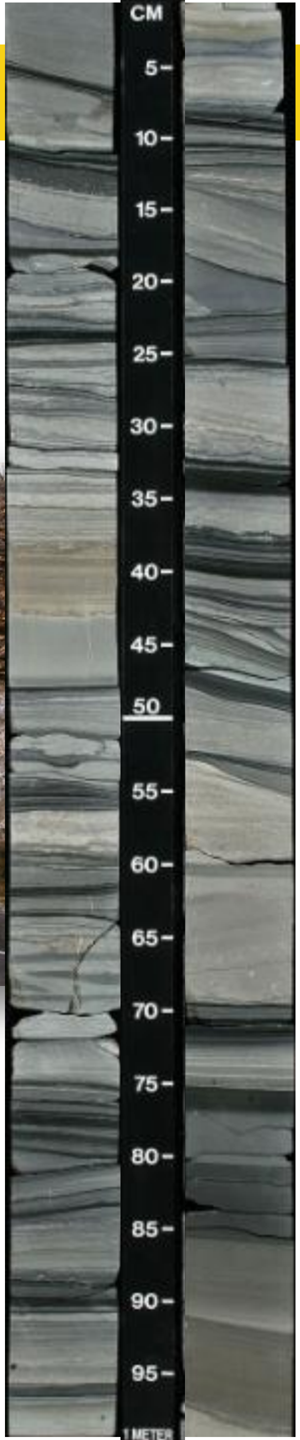
Middle Cenomanian (95.8Ma)

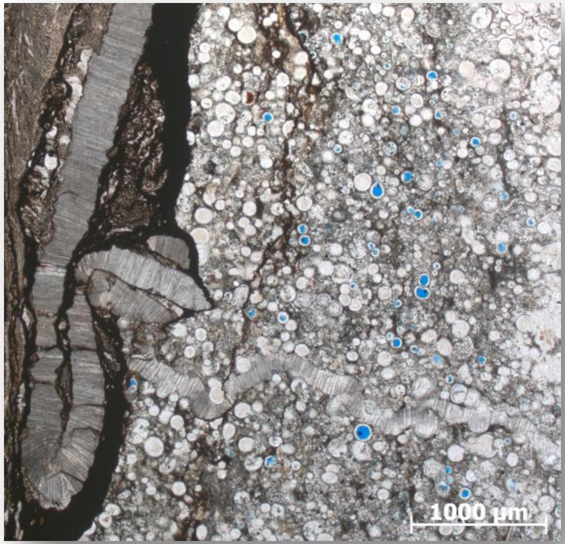
Definitions: Cycles and Motifs

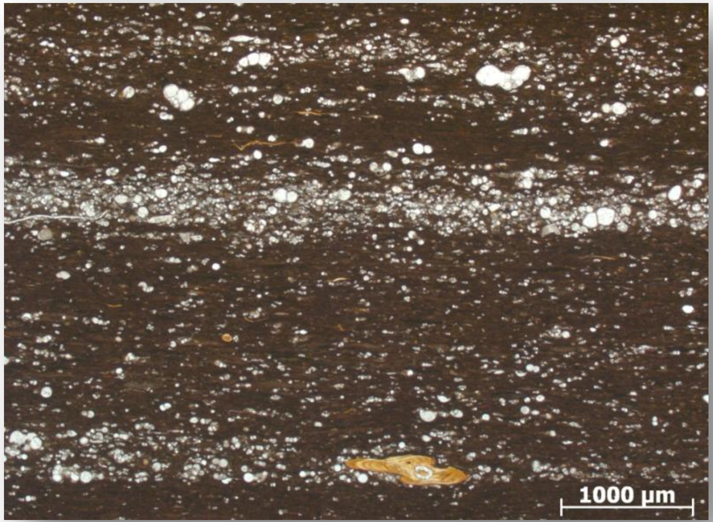
- Cycle – a series of connected events that proceed forward, returning to a starting point before repeating. When applied to a sedimentary sequence, ***cycles are a distinctive series of lithologies that are arranged vertically in a repetitive fashion***.
- Carbonate depositional cycle - a conformable succession of genetically related subtidal subfacies bounded by peritidal subfacies, subaerial exposure surfaces, and/or marine flooding surfaces. Cycles are the thinnest mappable allocyclic or autocyclic depositional unit.
- Motif - ***recurring depositional thematic elements within a succession that represent lithostratigraphic subsets within the evolution of a formation***.
- In this case, we arbitrarily mark cycle tops at the top of a limestone bed, making no inherent presumption about shallowing, deepening, or driving mechanism.

Carbonate Motifs in the Eagle Ford Fm.

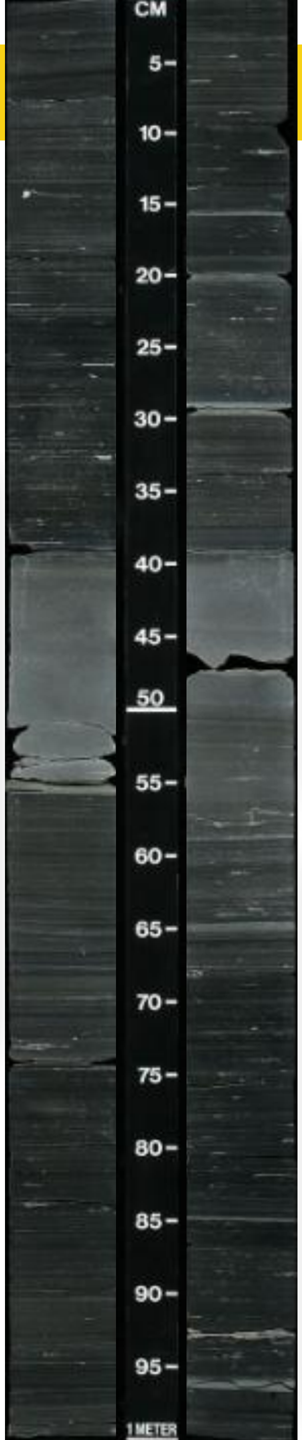
Motif 1 – Basal reworked deposits

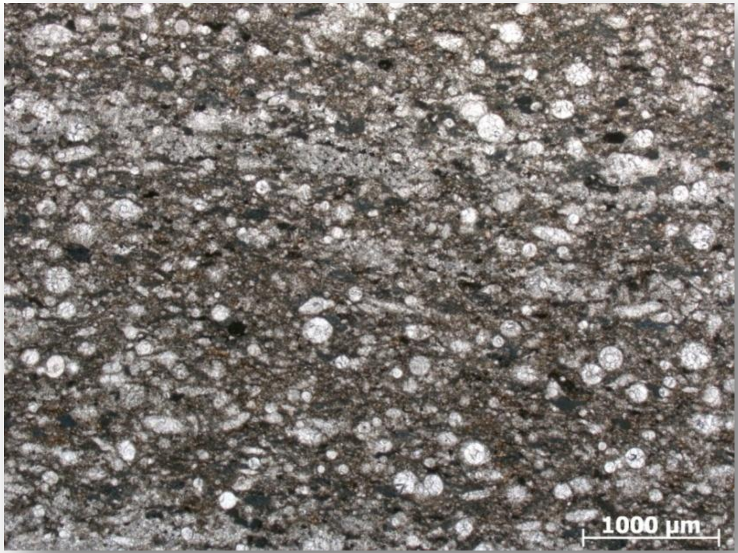


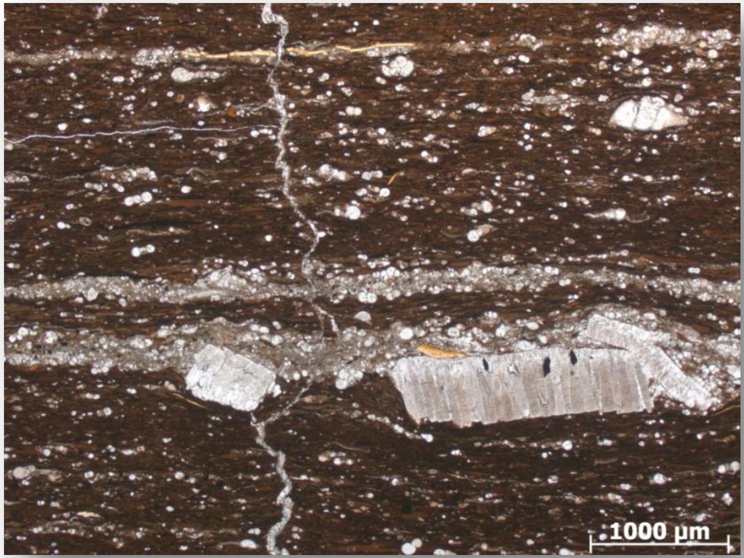




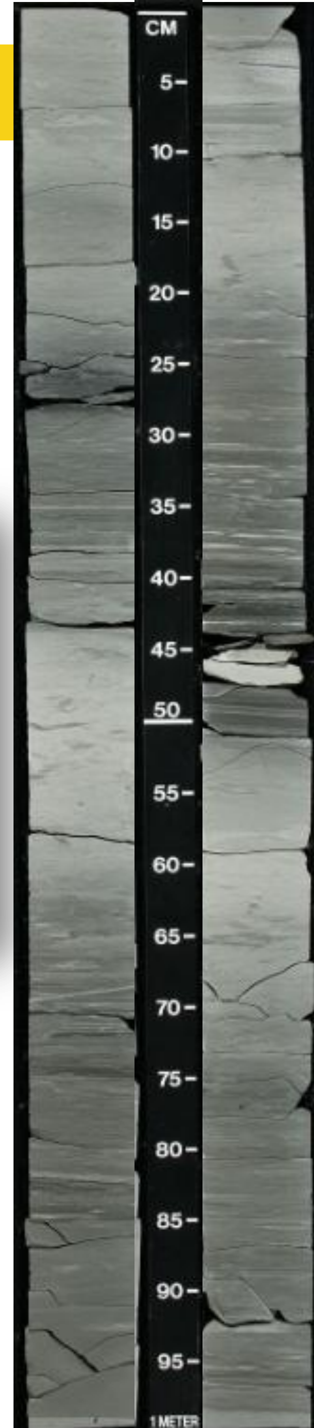
Motif 2 – Replaced cycles

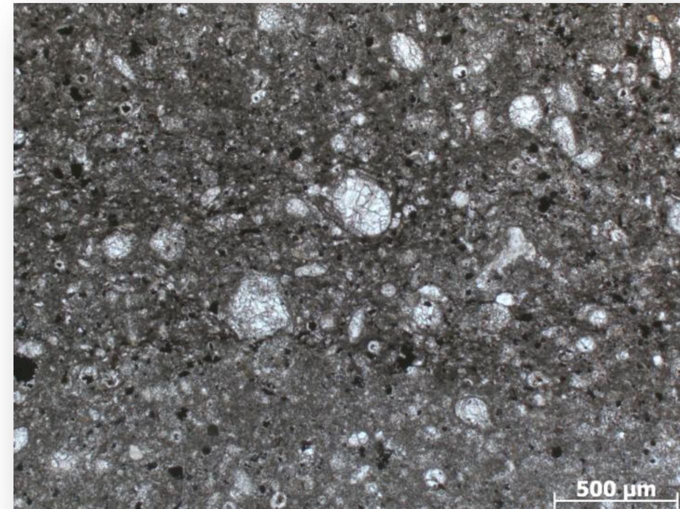


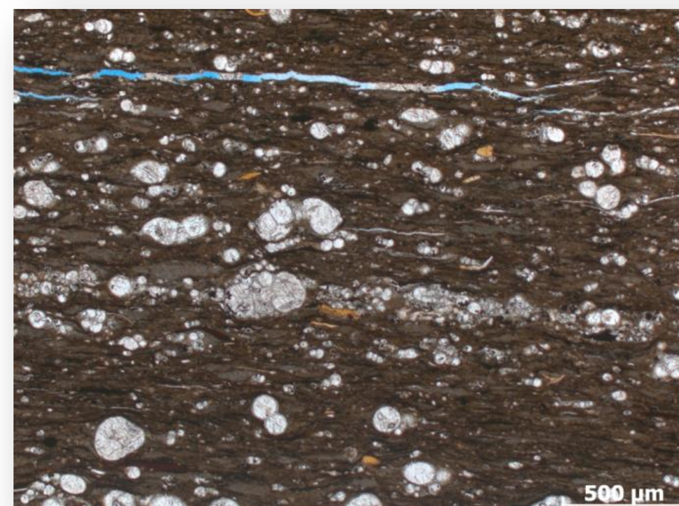




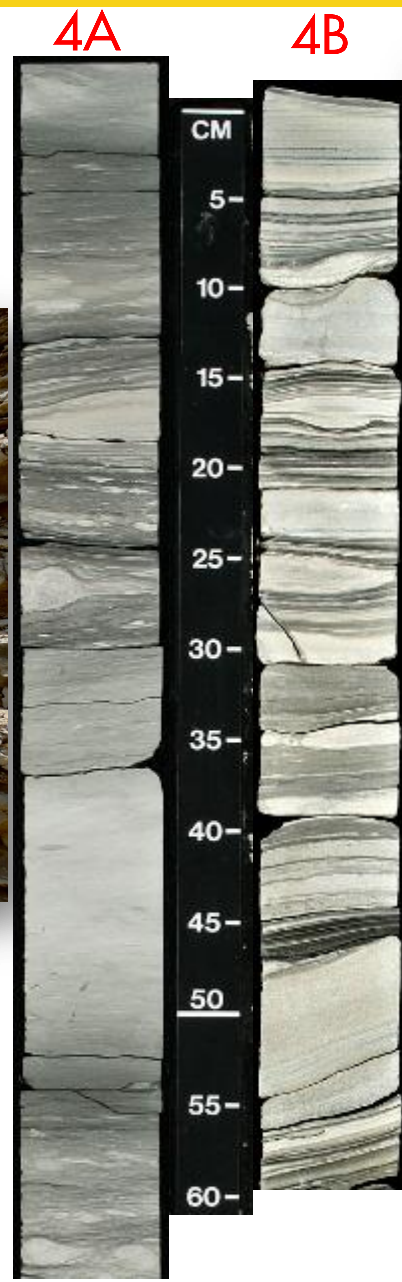
Motif 3 – Bioturbated cycles

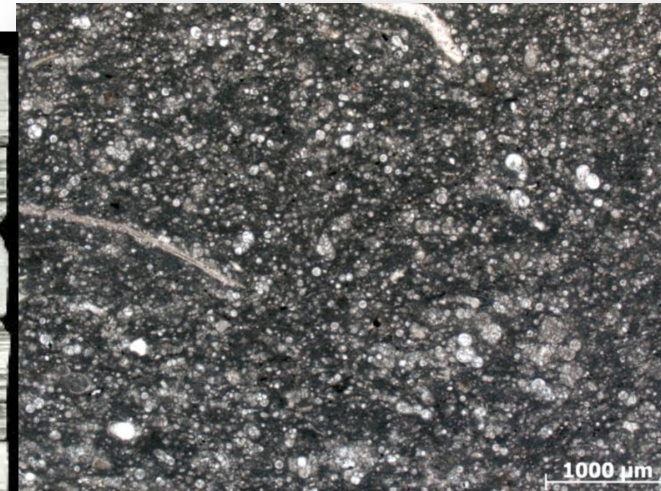






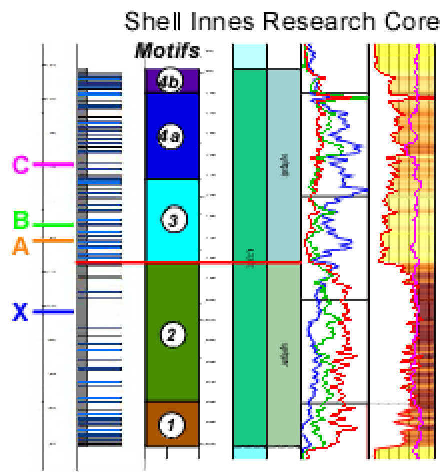
Motif 4 – Nodular cycles

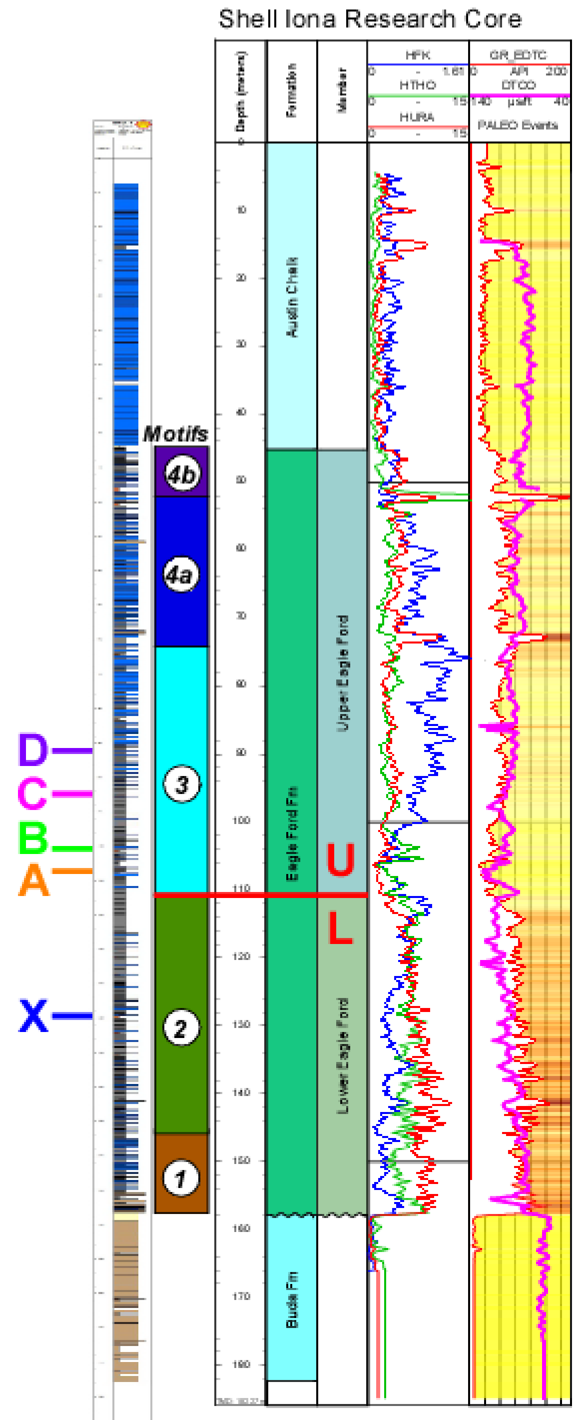




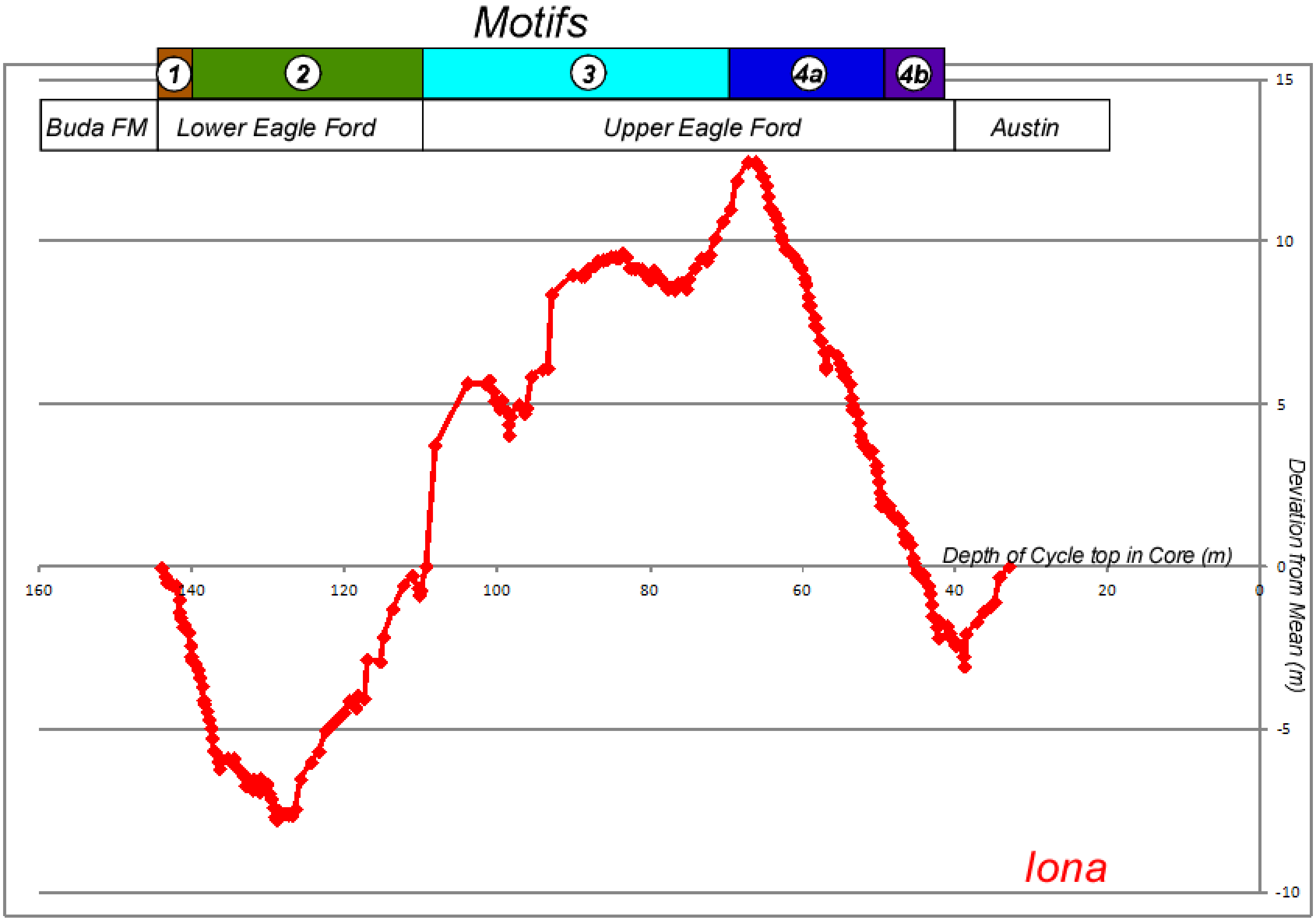
Cycle Stacking in the Eagle Ford Fm.

Dataset – Research Cores

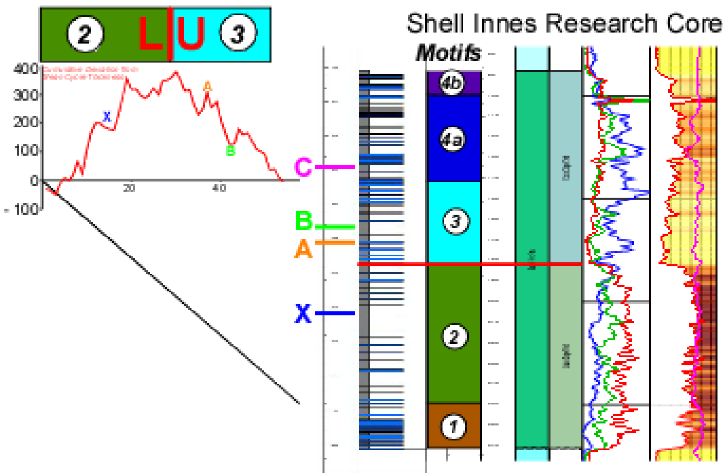


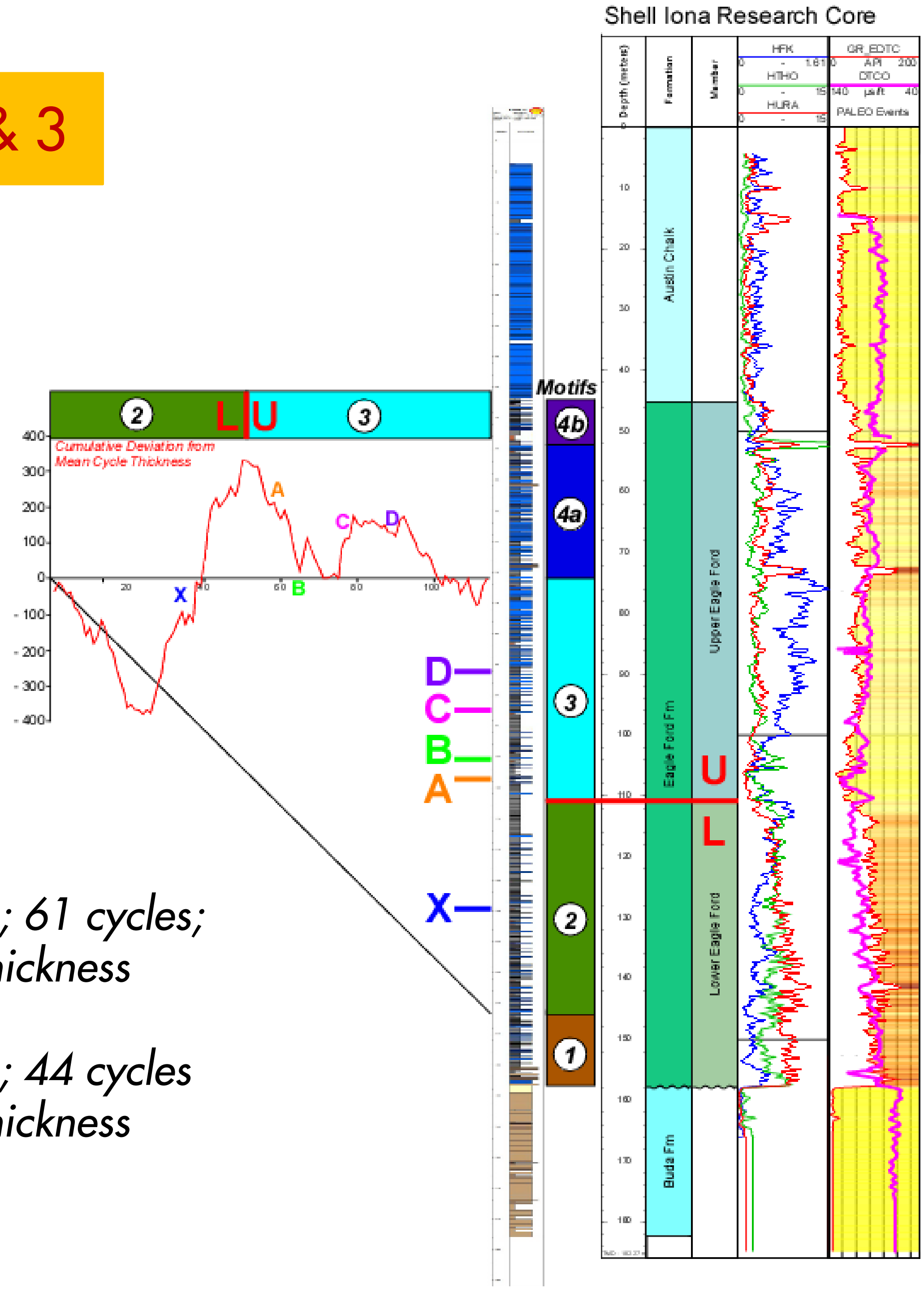


Overall cycle stacking



Cycle stacking within motifs 2 & 3





Innes

-M3: 12.15m; 26 cycles; 47cm avg. thickness

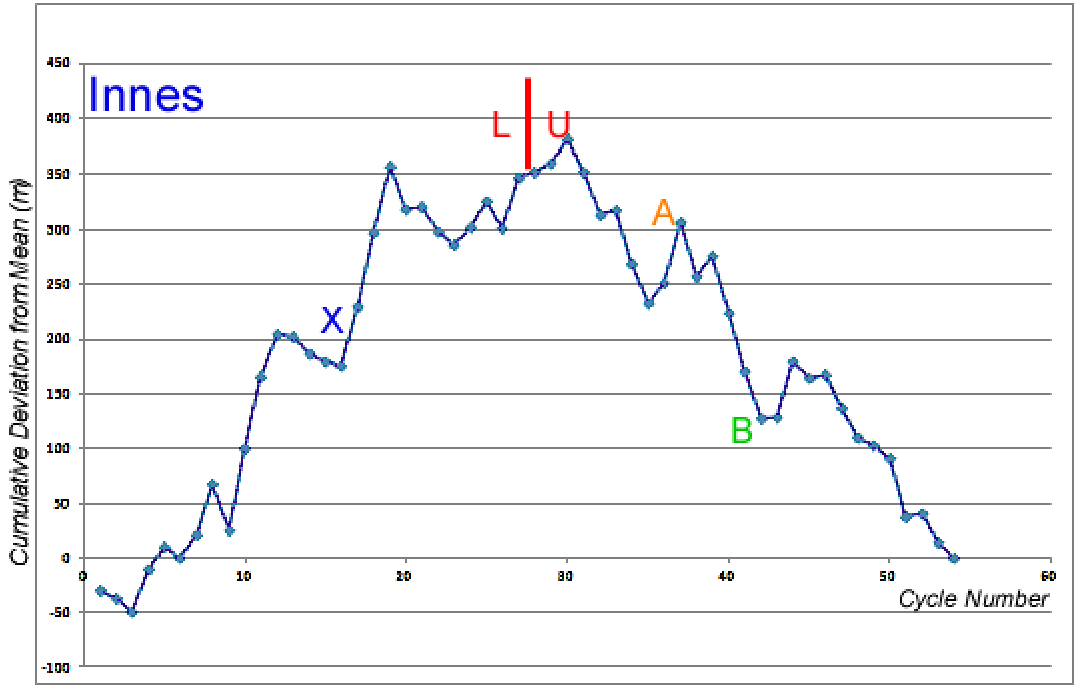
-M2: 20.45m; 28 cycles; 73 cm avg. thickness

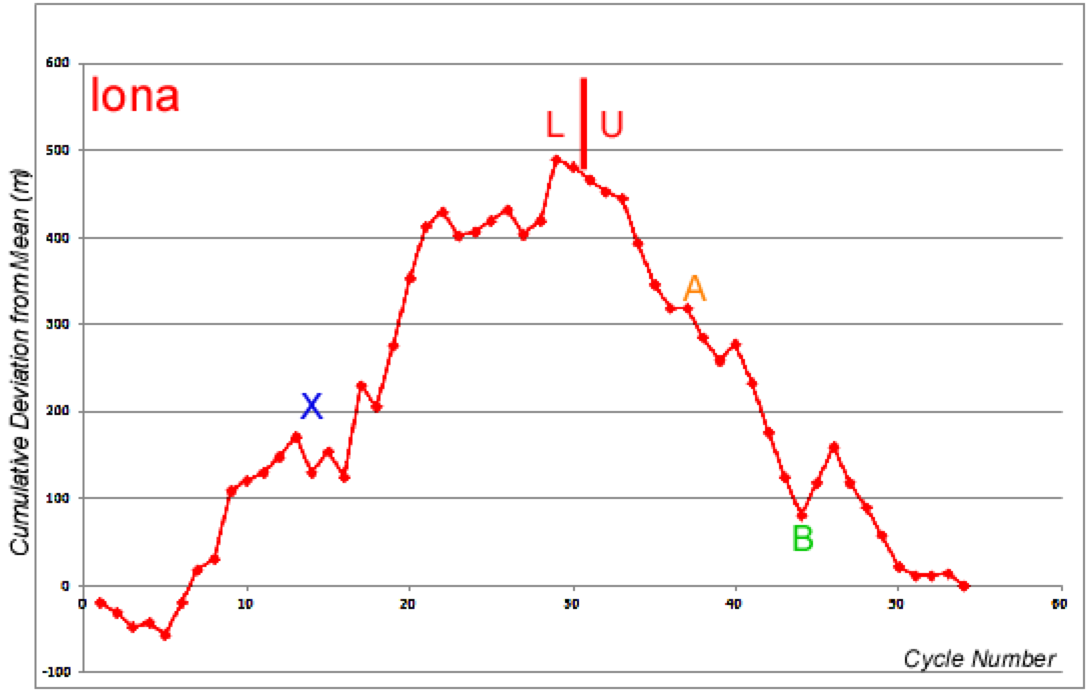
Iona

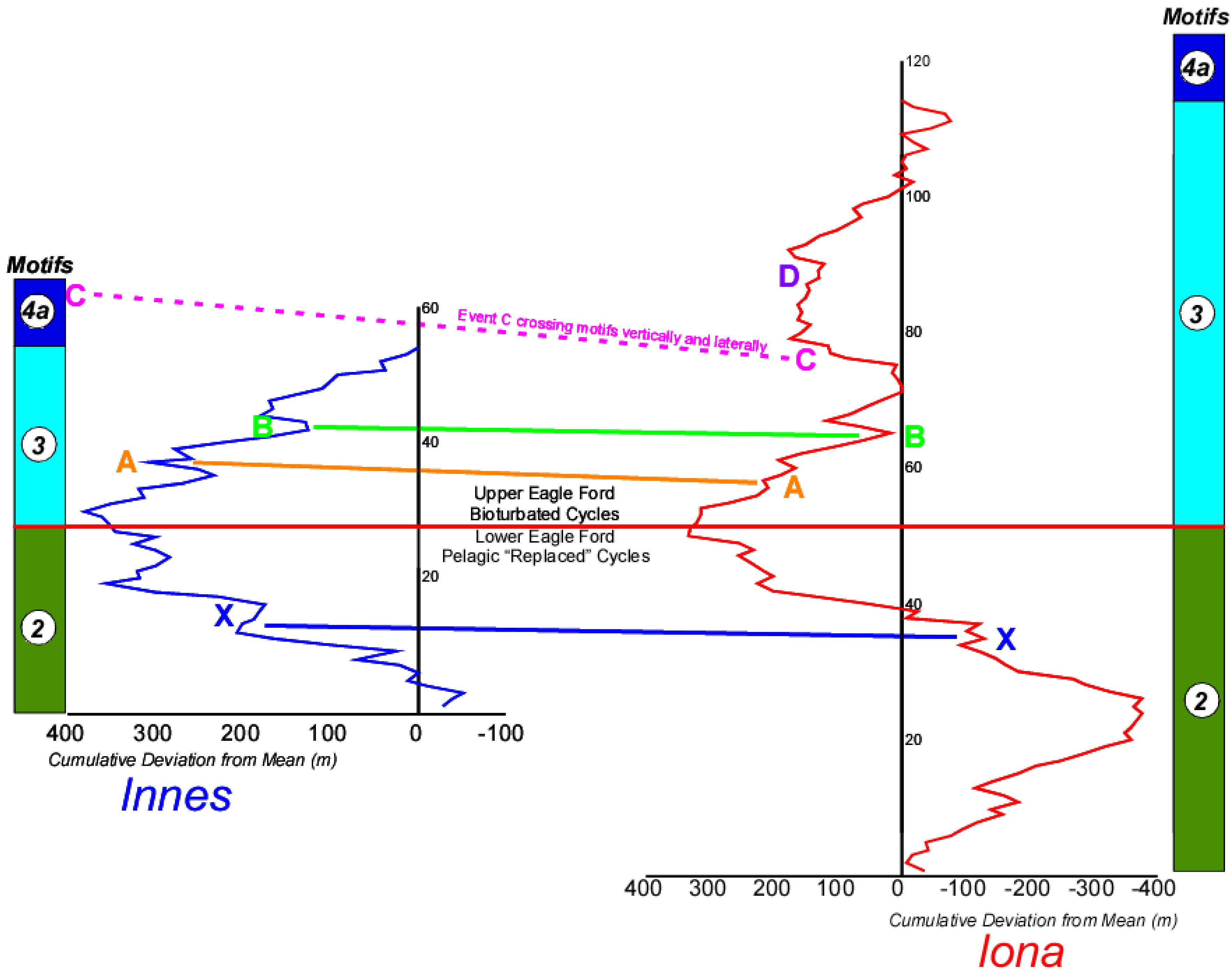
-M3: 40.56m; 61 cycles; 60 cm avg. thickness

-M2: 28.14m; 44 cycles 65 cm avg. thickness

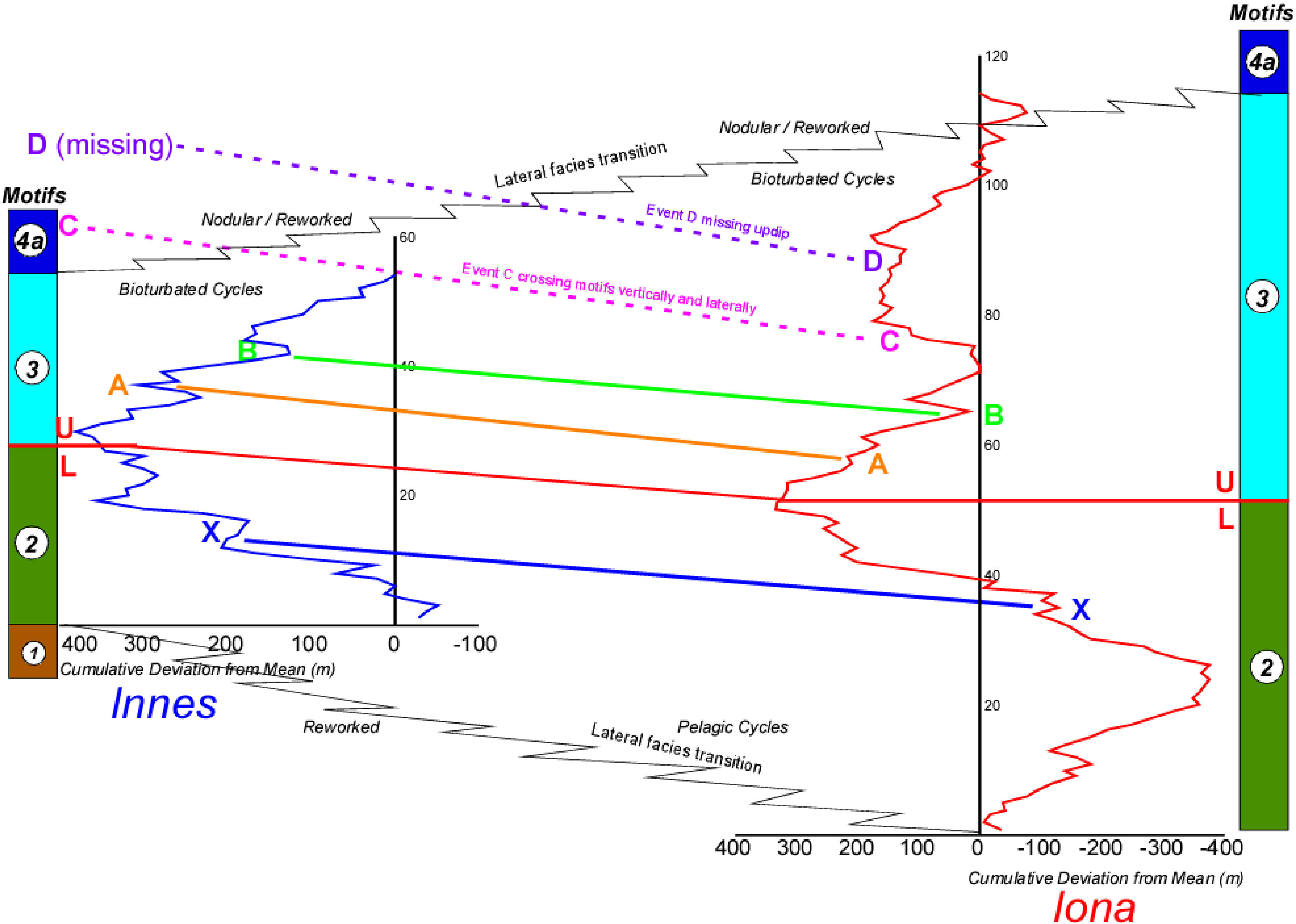
"Core" cycle stacking







Motifs
4a
3
2
C
Event C crossing motifs vertically and laterally
C
D
B
B
A
A
X
X
Upper Eagle Ford
Bioturbated Cycles
Lower Eagle Ford
Pelagic "Replaced" Cycles
60
40
20
120
100
80
60
40
20
400 300 200 100 0 -100
Cumulative Deviation from Mean (m)
Innes
400 300 200 100 0 -100 -200 -300 -400
Cumulative Deviation from Mean (m)
Iona



Motifs
4a
3
2
1
D (missing)
Event D missing updip
C
Event C crossing motifs vertically and laterally
B
A
U
L
X
D
Nodular / Reworked
Lateral facies transition
Bioturbated Cycles
Reworked
Pelagic Cycles
120
100
80
60
40
20
0
400
300
200
100
-100
-200
-300
-400
Cumulative Deviation from Mean (m)
Innes
Iona

Conclusions

- The Eagle Ford can be subdivided into depositional motifs that are defined by internally repetitive depositional themes, likely heavily influenced by depositional setting and environmental conditions.
- Wells have consistent motif types and vertical arrangement, but different thicknesses and numbers of cycles per motif.
- Very thin bedded cycles at the base and top of the Eagle Ford (motifs 1 and 4b) reflect reworking and winnowing by current energy. Clear thickening and thinning trends are clearest within the core of the formation (motifs 2 and 3).
- Temporal markers fall at consistent positions within the stacking, suggesting that cycle set bundling is contemporaneous between wells and therefore serves as its own correlative element.
- At least one marker crosses facies boundaries vertically between wells indicating a lateral facies transition between localities. Lateral facies transitions may relate to more complex depositional geometry.